Acquired Brain Injury: Social Cognitive Ability as a Predictor of Psychosocial Functioning and the Influence of Sex

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Statement of Sources

I declare that this report is my own original work and that contributions of others have been duly acknowledged.

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Abstract

Acquired Brain Injury (ABI) is an extremely prevalent; 1 in 45 Australians have experienced one (AIHW, 2007). Impairments to social cognition are well documented in ABI literature (Adolphs, 2010; McDonald, 2013), and the consequences of such impairments have the potential to be devastating to psychosocial outcomes (Ubukata et al., 2014). Research suggests that males may be more vulnerable to these ABI-related social cognitive impairments than females. The current study aimed to investigate the interaction between sex and social cognition, and how predictive these factors are of psychosocial functioning following an ABI.

The current study examined 39 ABI participants and 34 age and sex matched controls on a range of social cognitive and psychosocial functioning measures through self, informant and object reports. A series of 2 (male vs female) x 2 (ABI vs control) ANOVAs were conducted to compare social cognitive ability. The results revealed that males performed worse than females on all measures of social cognition in the ABI group. The effect of sex was significant for the IRI, and the ER SEQ informant scores revealed a trend towards this also. All three TASIT-S subscales revealed a significant interaction between presence of an ABI and sex. This supported the hypothesis that an ABI would negatively impact social cognition for males more than females. Six hierarchical regressions were conducted to determine the predictive value of social cognition for psychosocial functioning. For males (unlike females), the final regression model significantly predicted performance on all three SPRS subscales; a strong association. These findings suggest that for ABI males, social cognitive ability was impaired to the extent that it predicted psychosocial functioning. Results highlight the need for sex and social cognition to be considered in ABI research and interventions.

The brain is fundamental to every aspect of physical, cognitive, sensory, behavioural and social functioning. After an acquired brain injury (ABI) impairment to several of these domains may become apparent (AIHW, 2007; Fortune & Wen, 1999). These impairments can be important predictors of functional limitations (Hanks, Rapport, Millis & Deshpande, 1999; Spitz, Ponsford, Rudzki, & Maller, 2012; Struchen et al., 2008). Identification of the characteristics that most strongly predict functional outcomes is vital not only to create tailored and effective treatment programs, but to ensure that they are cost-efficient (Üstün, Chatterji, Bickenbach, Kostanjsek, & Schneider, 2003). This is especially the case as ABI rehabilitation is associated with huge costs (The Victorian Neurotrauma Initiative, 2009). In addition to this, it has become increasingly requested of neuropsychologists (particularly in rehabilitation settings) to provide a prediction of functional abilities from test results. Research to enable this however, is limited (Struchen et al., 2008). Examining factors such as sex and social cognition in relation to psychosocial function may allow for more accurate estimations of future functioning, thus aiding in the development of effective and tailored rehabilitation programs.

Social cognition refers to the set of abilities that are required to successfully interact with, and understand the beliefs, feelings and intentions of others (Adolphs, 2001; McDonald, 2013). Deficits to social cognition have been well documented in ABI populations, and are thought to be the main cause of characteristic changes seen following an ABI (Babbage et al., 2011; Douglas & Spellacy, 2000; Lezak, 1978; McDonald, 2013). Deficits to social cognition are thought to be particularly damaging as preliminary research suggests they may directly impact functional outcomes following an ABI (Morton & Wehman, 1995; Struchen et al., 2008; Ubukata et al., 2013). However, despite the seriousness and extent of consequences

that stem from poor social cognition, there are currently no clear methods for identifying which individuals are at risk of experiencing these deficits.

Rigon et al. (2016) propose that sex may have an important effect on social cognition. In healthy individuals, research has demonstrated sex differences in a number of specific social domains with females often outperforming males (Collingnon et al., 2010; Krach et al., 2009; Weisenbach et al., 2014). There is also evidence of a female advantage in social cognition occurring after an ABI (Schmidt, Hanten, Li, Orsten, & Levin, 2010; Turkstra, 2008; Zupan, Babbage, Neumann, & Willer, 2016). It in light of these findings, and in combination with the evidence that social cognitive ability may predict functional limitations (Morton & Wehman, 1995; Struchen et al., 2008; Ubukata et al., 2013), it is conceivable that females may hold an advantage over males following an ABI.

It is also possible that the success of males and females in terms of their psychosocial functioning, may depend in part on their social cognitive ability. By examining whether social cognitive ability predicts psychosocial functioning and how this may differ on account of sex, it may allow for the identification of individuals most at risk of experiencing functional impairments, and shed light on the individual variation in outcomes that is apparent following an ABI. The current study therefore aims to clarify the role of sex in social cognition and the impact this may have on psychosocial functioning in ABI populations.

Acquired Brain Injury

An ABI is defined by the Australian Institute of Health and Welfare (AIHW; 2007) as damage to the brain occurring after birth. Acquired Brain Injuries (ABIs) are a major global issue, and in Australia, 1 in 45 individuals have reported experiencing an ABI in their lifetime (AIHW, 2007). As ABIs may be acquired

when individuals are young; the psychosocial and functional limitations can persist through-out life and account for a considerable proportion of productivity loss and health care costs (Benedictus, Spikeman, & van der Nallt, 2010; Thornhill et al., 2000), for example the average lifetime cost for an individual with a severe traumatic brain injury (TBI) in Australia is $4.8 million (The Victorian Neurotrauma Initiative, 2009). The term ABI encompasses a range of brain injuries, and see Figure 1. TBI is the most prominent type, and often the main focus of brain injuries research (AIHW, 2007). Other types of ABI include stroke, hypoxia, tumours, infection, poisoning and substance abuse, and degenerative neurological diseases (Fortune & Wen, 1999). While heterogeneous in nature, ABIs may be identified by their conformity to a number of clinical attributes. These categories include pathoanatomical features (location and pathological features), the severity (based on the acute effects), or cause of the brain injury (Koehler, Wilhelm, & Shoulson, 2011). Damage to the brain may be focal in nature (damage in a precise location) or a diffuse cerebral injury (more extensive damage occurring through-out the brain; Levin, Benton, & Grossman, 1982; Lezak, 2012). Brain injuries may also be distinguished by whether they occur suddenly such as trauma to the brain, stroke or oxygen deprivation and those that develop over time such as degenerative neurological disease or brain tumour. All of these factors may influence the nature and severity of resulting disability and functional impairment (Fortune & Wen, 1999).

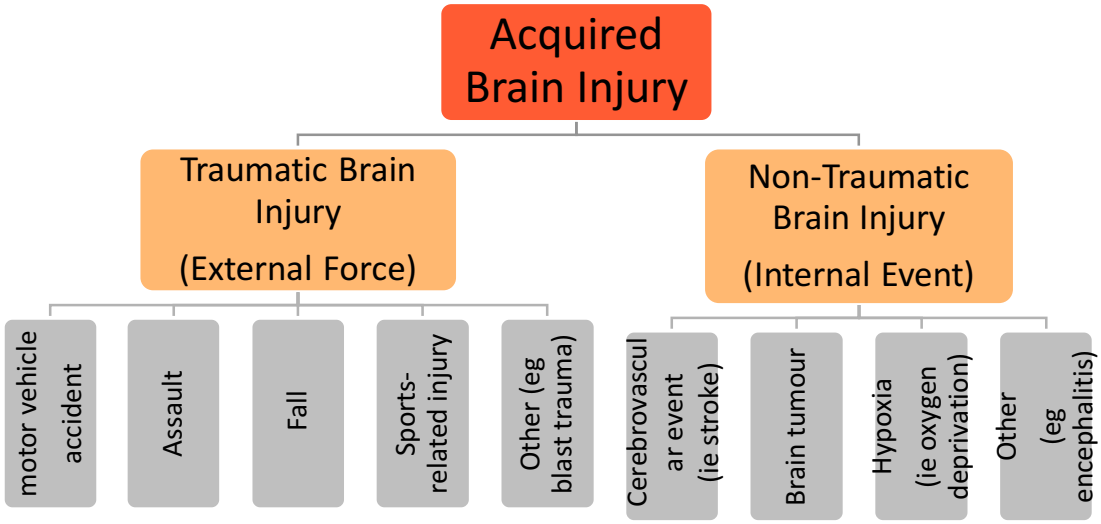


Figure 1. Classification of ABI

The consequences of an ABI are extremely complex and affect individuals in a variety of ways (Fortune & Wen 1999), often resulting in significant disabilities of a physical, emotional, social and cognitive nature (AIHW, 2007). The wide range of effects from an ABI can be both short term and long term in nature; affecting both the individual and those around them (Koehler, Wilhelm, & Shoulson, 2011). Deficits to physical functioning may include impairments to motor skills or perception (Cancelliere, Donovan, & Cassidy, 2016; Biernaskie, Chernenko, & Corbett, 2004); psychosocial impairments may include disinhibition and emotional instability (O'Rance & Fortune, 2007) and cognitive impairment may refer to difficulties with memory, attention or problem-solving difficulties (McDonald, 2013; Ownsworth & Fleming, 2005). Social cognitive impairments (such as difficulties with emotion perception and recognition, and reduced empathy) are acknowledged to be some of the most challenging consequences of a brain injury (Bornhofen &

McDonald, 2008; Babbage et al., 2011; Milders et al., 2003; Spikeman et al., 2012; Williams & Wood, 2010). Collectively, these deficits are so central to functioning, that they can have a profound detrimental impact on functional outcomes. This is especially apparent in ABI populations where individuals often experience poorer outcomes in contrast to other acquired disabilities (Temkin, Corrigan, Dikmen, & Machamer, 2009).

The direct and indirect effects of these deficits may act individually or in combination to cause a variety of functional limitations following an ABI. These can range difficulties with basic everyday activities such as personal care and mobility to more complex psychosocial issues such as employment, social relations and independent living difficulties (Temkin et al., 2009). In their literature review, Temkin et al (2009) examined the research on these higher-level functions, and found that individuals with TBIs had a worse employment status than controls. There also appeared to be a strong relationship between return to work rates and injury severity. In regard to social relationships, TBI individuals experienced a range of problems concerning social communication and behaviour; such as experiencing significant loss of friends and a heavy reliance on parents. Leisure activities were also disrupted and quality of life was significantly reduced.

How successful an individual is in terms of their functional outcomes post injury may depend on a variety of factors. Examining whether specific cognitive functions, such as social cognition, predict impairment to functional outcomes may provide insight into the individual variation seen following an ABI. In turn, this could assist in identifying individuals at risk of experiencing more severe functional impairments in the hopes of providing early interventions.

Social Cognition

The term social cognition encapsulates the set of abilities that allow for successful interaction with others and an accurate understanding of the beliefs, feelings and intentions of others (Adolphs, 2001; McDonald, 2013). Social cognition is facilitated through the perception and interpretation of social stimuli which may be non-verbal such as facial expressions or eye gaze, or verbal which require abstract reasoning in order to decode (Frith & Frith, 2010; Mike et al., 2013). The broad range of skills that make up social cognition, range from seemingly simple processes such as perceiving facial emotions, to more complex process such as inferring the mental states of others (Theory of Mind; Adolphs, 2003; Ubukata et al., 2014).

There are various conceptualisations as to how the various components of social cognition may be distinguished. Frith and Frith (2010) refer to two systems that underpin social cognition; the mentalising system (or 'cold' cognition) which enables someone to take another's perspective and understand their feelings, beliefs and intentions, and the mirror system (or 'hot' cognition) which involves identifying and empathizing with the emotions of another. An alternative model refers to social cognition as being broken down into three distinct processes; perception, evaluation and regulation (Adolphs, 2010; McDonald, 2013). Perception of social stimuli is vital to social cognition; it refers to both explicit processing (controlled, slow and conscious), and implicit processing (reflexive, fast and unconscious) of social stimuli (Adolphs, 2010; McDonald, 2013). Evaluation refers to the rapid and automatic process of interpreting mental states and emotionally salient information (McDonald, 2013). Lastly, is the effortful regulation of responses and contextualization which refers to processes such as emotional regulation and cognitive control. This final

component is however, unlikely to be a process specific to social cognition (McDonald, 2013).

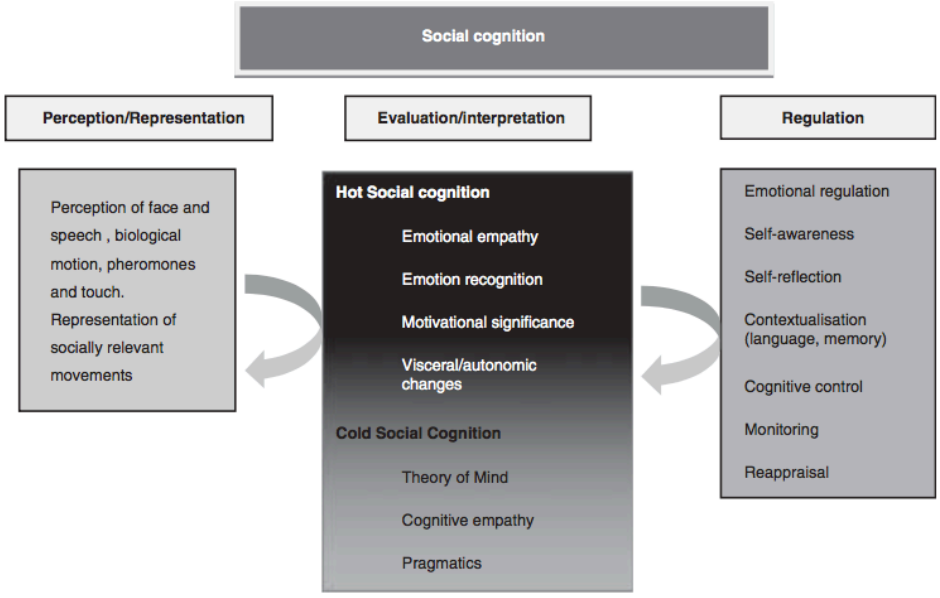


Figure 2. Conceptualization of Social Cognition and its components as proposed by Adolphs (2010). Retrieved from McDonald (2013). Impairments in Social Cognition Following Sever Traumatic Brain Injury. *Journal of the International Neuropsychological Society, 19, p. 232.*

How distinct the processes of social cognition are from more general domains of cognitive functioning such as working memory or cognitive flexibility, is the subject of much debate. While research exists suggesting a correlation between cognition and social cognition (e.g. Eslinger, Moore, Anderson & Grossman, 2011), there is also evidence to suggest that they are distinct processes (e.g. Lough, Gregory & Hodges, 2001). What is perhaps more feasible, is that social cognition encompasses a broad range of processes that are both specialized and non-specialized (Adolphs, 2001; McDonald, 2013). While a correlation may exist between some aspects of social cognition and general cognitive processes, it remains important to examine social cognition (as a whole), as process independent from general cognition.

Social Cognition Following an ABI

A number of factors influence how successful an individual is in terms of their psychosocial functioning following an ABI. Social cognition is one such factor that when impaired, is considered to have particularly devastating effects (Spikeman et al., 2012; Struchen et al., 2008). It is also a common impairment in ABI populations, and especially so in TBIs, as certain brain structures such as the prefrontal cortex, thought to be involved in aspects of social cognition (e.g. emotion recognition and social motivation), are particularly vulnerable to TBI (Bicks, Koike, Akbarian & Morishita, 2015; Benedictus, Spikman, & van der Naalt, 2010; McDonald, 2013; Spikeman et al., 2012). A number of aspects that make up social cognition have been found to be impaired following an ABI. These include emotion perception and recognition (Bornhofen & McDonald, 2008; Babbage et al., 2011), Theory of Mind (McDonald, 2013; Milders et al., 2003), empathy (de Sousa et al., 2011; Williams & Wood, 2010), understanding non-literal communication such as sarcasm or deception (Channon, Pellijef, & Rule, 2005; Honan et al., 2016) and self-awareness (Spikman et al., 2010). An impairment to any of the various components of social cognition may be particularly disabling as they have been argued to be an evolutionary imperative (Adolphs, 2003); an integral part of human nature, vital for effective and appropriate integration and participation in society. On account of this, any impairment to social cognition can therefore be expected to predict difficulties to a number of functional domains.

Perhaps most consequentially however, is the flow on effects produced by these deficits which have the potential to cause difficulties in real-world functioning (Temkin et al. 2009). Ubukata et al. (2014), examined the impact of various aspects of social cognition on psychosocial functioning following an ABI in a sample of 20

participants who had sustained a TBI. The researchers measured social cognition through facial emotion perception and Theory of Mind tasks, and functional outcomes by assessing physical and cognitive independence, mobility, occupation status, social integration and economic self-sufficiency. Findings from this study revealed a significant correlation between social cognition (eye expression identification; a ToM task) and functional outcomes (difficulties in every day communication).

Social cognition involves many complex processes that are fundamental to successful functioning in many facets of life. Within the set of abilities that entail social cognition, exist a number of features more commonly impaired following an ABI that may impact results when examining social cognitive ability. Self-awareness deficits in terms of an ABI refer to a failure to recognise impairments that have occurred as a result of a brain injury (Fitzgerald, O'Keeffe, Coen, & Dockree, 2012). Deficits to self-awareness are a common experience in ABI populations (Prigatano, 1991) and can impact and distort testing, especially where self-report measures are used (Honan, McDonald, Sufani, Hine, & Kumfor, 2016). Despite this, research often relies on self-report measures of social cognition, especially when measuring empathy (Njomboro, 2017). The use of multiple measures (e.g. informant or objective) is recommended to account for these deficits. In addition, a fundamental aspect of social cognition, is the ability to interpret language and emotion. Part of this ability involves interpreting non-literal communication such as sarcasm or deception. For individuals with an ABI, this can prove particularly difficult (Channon, Pellijef, & Rule, 2005), and negatively affect scores on objective measures of social cognition that depict such interactions (i.e. the TASIT-S; Honan et al., 2016). Examining the features that may impact how an individual may score

on measures of social cognition will allow for a more in-depth examination of social cognitive ability.

The Influence of Sex on Outcomes Following ABI

One factor which has been identified in the literature as potentially interacting with ABI outcome is biological sex (Slewa-Younan, van den Berg, Baguley, Nott & Cameron, 2008). Sex is a factor vital to examine in any health-related research as differing biology can have a huge impact on a variety of health processes and affect how males and females respond to different treatments (Johnson, Greaves, & Repta, 2007). In regard to ABIs, it is commonly accepted that sex is a predictive factor in terms of acquiring a brain injury, with males twice as likely as females to develop an ABI and more likely to do so in a violent manner (Australian Institute of Health and Welfare, 2007; Gerhart, Mellick, & Weintraub, 2003). There is also evidence to suggest that sex may influence the pathological responses following ABI (Roof & Hall, 2000). Despite this, research has failed to find any clear consensus as to whether a sex advantage exists for both psychosocial outcomes (e.g. Bazarian, Blyth, Mookerjee, He, & McDermott et al., 2010; de Guise et al., 2014) and overall outcomes (Cancelliere, Donovan, & Cassidy, 2016; Slewa-Younan, et al., 2008) following an ABI. There is however, evidence to suggest females experience better recovery outcomes (Gibson, Gray, Bath, & Murphy, 2008) and an advantage for social and relationship outcomes after TBI (Farace & Alves, 2000).

The Role of Sex in Social Cognition and Psychosocial Function Following ABI

One way in which sex may influence ABI outcomes, is through social cognition. Deficits to social cognition have been well documented in ABI populations as having particularly detrimental effects (Babbage et al., 2011;

McDonald, 2013; Douglas & Spellacy, 2000; Spikeman et al., 2012; Struchen et al., 2008). Research has examined whether location of damage, severity of damage, or other non-social cognitive skills are risk factors for social cognitive impairment, however findings remain inconclusive (Green, Turner, & Thompson, 2004; Rigon, Turkstra, Mutlu, & Duff, 2016; Rosenberg, Dethier, Kessels, Westbrook, & McDonald, 2015). Rigon et al., (2016) suggest however, that sex may be an important predictor of social cognitive ability. In healthy individuals, research has demonstrated sex differences in specific social domains. For example, when interacting with emotional stimuli, neural activity differs between males and females, females also outperform males in facial recognition, facial emotion recognition, vocal emotion recognition and in ability to deduce goals and intentions of others (Collingnon et al., 2010; Krach et al., 2009; Weisenbach et al., 2014). A number of studies found that in ABI cohorts, females out performed males in Theory of Mind tasks, facial affect-recognition, recognising facial and vocal emotions and emotional inferencing (Schmidt, Hanten, Li, Orsten, & Levin, 2010; Turkstra, 2008; Zupan, Babbage, Neumann, & Willer, 2016). Males with ABIs have also been found to perform worse on measures of social cognition than their healthy counterparts, unlike ABI females, whose performance was similar to that of female controls (Rigon et al., 2016).

While the literature in this area often demonstrates null findings in regard to sex differences in psychosocial functioning, this may be a result of methodological issues (e.g. reliance on self-report). In addition, there is some evidence to suggests females may experience better psychosocial outcomes than males (Farace & Alves, 2000; Niemeir et al., 2007). In light of these findings, it may be suggested that females may possess greater resilience against social cognitive deficits associated

with an ABI. The success of males and females in terms of their psychosocial functioning, may therefore depend in part on their social cognitive ability.

Justification, Aims and Hypotheses

Research to enable a prediction of functional abilities from test results is limited (Struchen et al., 2008). However, deficits to social cognition are potentially influential in psychosocial functioning, and research indicates that sex may be an important predictor of social cognitive impairment. Furthermore, as males are more likely to obtain an ABI than females, research and rehabilitation often ignores gender-specific health (Mukherjee, Reis, & Helloer, 2003). Minimal research therefore exists investigating the prediction of psychosocial functioning from both ABI related social cognitive impairment and in addition, the role of sex; despite its implications for identifying individuals at risk of experiences deficits, and tailoring treatments accordingly. Comparisons of social cognitive ability between individuals with ABIs and controls are also lacking, along with the use of multiple measures of social cognition (i.e. self, informant and objective reporting). This study appears to be the first of its kind to examine and address all of these factors.

There are also some limitations to previous research. For example, a common limitation of ABI research is the lack of control group. Without a control group, strong conclusions regarding effects and outcomes of an ABI cannot be drawn (Temkin et al., 2009). This is especially true for the measurement of social cognition following an ABI. As sex differences are known to occur in healthy populations (Collingnon et al., 2010; Krach et al., 2009; Weisenbach et al., 2014), any differences observed in social cognition between males and females may simply be a reflection of these pre-existing differences.

The use of self-report is also criticised (Temkin et al., 2009) as results are vulnerable to distortion resulting from impaired self-awareness, attentional bias, emotional distress and cognitive impairments which may affect complex language processing and attention; all of which ABI individuals are known to suffer from (Green, Pakenham, & Gardiner, 2005; McDonald, 2013). Honan et al. (2016) state these subjective measures may result in an inaccurate or biased representation of social cognition ability. This is apparent in the literature which has demonstrated that ABI individuals' often under-report difficulties and are less accurate and consistent as opposed to controls (Fleming et al., 1996). Fleming et al. (1996) therefore suggests the use of multiple measures (i.e. self-report, informant report and objective report) in order to provide the most accurate measurement. The current study will therefore adhere to the recommendations of Fleming et al., by utilising both a control group and multiple reporting methods to ensure a reliable indication of social cognitive ability is obtained.

The aim of the current thesis is twofold: Firstly, examining whether sex differences impact on deficits to social cognition following ABI, could allow for more accurate estimations of future functioning. Secondly, determining how impairments to social cognition may affect an individual's functioning in various domains post-injury will also demonstrate how influential social cognition is in various aspects of psychosocial functioning following an ABI. The present study therefore aims to clarify the role of sex in social cognition and the impact this may have on psychosocial function in ABI populations. It was hypothesized that:

1. Sustaining an ABI will have more of a negative impact on social cognitive ability for males than females. This will be demonstrated by ABI males experiencing significantly lower scores on self-report,

informant-report and objective measures of social cognition than male controls; whereas it is predicted that females with ABIs will display similar scores on the same measures of social cognitive to female controls.

2. For males, social cognitive ability will be impaired to the extent that it will predict psychosocial function (i.e. work and leisure, relationships and living skills); whereas for females, deficits to social cognition will not predict psychosocial functioning.

Method

Participants

ABI participants were recruited through the Brain Injury Association of Tasmania (BIAT) in Hobart, and the Tasmanian Acquired Brain Injury Service (TABIS) in Launceston. Both organizations provide support for individuals living with ABIs, and their families. Healthy controls were recruited through word of mouth.

The sample consisted of 73 participants; 39 with an ABI and 34 age and sex matched healthy controls. The ABI and control groups did not differ significantly according to age, sex, education or anxiety. There were significant differences in TOPF and depression scores, however this did not impact results (see Table 1 for descriptive statistics and Design and Analysis section for a further discussion). Between males and females there were no significant differences on any demographic variables. (See Appendix A).

For ABI participants, exclusion criteria included severe deficits to speech, vision and hearing. For controls, participants were excluded if they had previously lost consciousness, had a physical psychiatric or neurological condition at any point,

an IQ of less than 70 as measured by the Test of Premorbid Functioning or if English was not their first language.

ABI characteristics are shown in Table 2. Where traumatic brain injury had occurred, injury severity was determined by duration of post traumatic amnesia (PTA) and classified according to recommendations by Lezak, Howieson and Bigler (2012). All but one participant had sustained their ABI over a year previously; a time period considered to be sufficient for functional impairments to stabilize (Ubukata et al., 2014). Within the ABI group, severity and time since injury did not differ between males and females. The majority of participants (80%) sustained severe ABIs. In the ABI group, more than half of individuals had psychiatric conditions (23% depression, 12% anxiety, 8% PTSD, 12% other), and more than half (64%) were currently using more than one type of medication. The high frequency of psychiatric conditions and medication usage reported in this sample is however, not uncommon in ABI populations (Temkin et al., 2009).

Table 1

Participant Demographic Characteristics: ABI vs Control

Demographics	ABI M/ n (SD/ %)	Control M/ n (SD/ %)	t / X^2	p	Cohens d/ Cramer's V
Sex					
Male (n = 42)	23 (59%)	19 (56%)			
Female (n =31)	16 (41%)	15 (44%)			
Total	39	34	.071	.790	.031
Age	47.44 (13.51)	45.24 (12.81)	.714	.478	0.17
Premorbid IQ	93.38 (18.34)	105.74 (12.61)	-3.386	.001	0.79
Education Level					
< Year 10	4	2			
Year 10-12	16	12			
Tafe	9	12			
University	10	8	1.55	.670	.146
HADS Anxiety	7.74 (4.94)	7.18 (4.20)	.530	.597	0.12
HADS Depression	5.05 (3.53)	3.41 (3.06)	2.12	.038	0.50

Table 2

ABI Characteristics

Characteristic	*N* (%)
Type of ABI	
Traumatic	20 (51.3%)
Stroke/ Aneurysm	9 (23%)
Tumour	4 (10.2%)
Other	4 (10.2%)
Multiple ABIs	2 (5.3%)
Time since injury (years)	
0-3	6 (15.4%)
4-6	7 (18%)
7-9	6 (15.4%)
>9	20 (51.2%)
Injury Severity (PTA)	
Mild (< 24 hours)	3 (7.7%)
Moderate (< 1 week)	4 (10.3%)
Severe (> 1 week)	31 (79.5%)
Not Applicable	1 (2.5%)

Apparatus/Instrumentation/Materials

Demographic Questionnaire

A demographic questionnaire was developed in order to determine the ABI and control participants' age, sex, level of education, relevant medial history and previous loss of consciousness. ABI participants were also asked to report the date and cause of ABI, treatment or rehabilitations and medication use. To determine the severity of brain injury, questions from the Galveston Orientation and Amnesia Test were incorporated into the questionnaire. This test has been demonstrated to be an accurate measure of post traumatic amnesia (PTA) duration (Lezak et al., 2012). ABI participants were given the option to allow researchers to access relevant medical records by signing a medical release form developed for the study (see Appendix B).

Test of Premorbid Functioning (TOPF)

A revised version of the Wechsler Test of Adult Reading, the TOPF (Wechsler, 2009) allows for a premorbid estimation of IQ. The TOPF tests verbal ability, a skill known to remain relatively stable following an ABI and therefore a recommended measure of premorbid IQ for ABI populations (Delis, Kaplan, & Kramer, 2009). The TOPF contains a list of 70 words with irregular grapheme-to-phoneme translation in increasing difficultly; each word correctly pronounced receives a score of 1 and an incorrect pronunciation, a score of 0. After five consecutive scores of 0, testing is ceased. The TOPF has been co-normed with the WAIS-IV. It is reported to have high internal reliability and test re-rest reliability, along with concurrent validity with verbal functioning in TBI populations (Chu, Lai, Xu, & Zhou, 2012).

Hospital Anxiety and Depression Scale (HADS)

The HADS (Zigmond & Snaith, 1983) is a 14-item scale that measures existing levels of anxiety (7 items) and depression (7 items). Items on the HADS can be scored on a four-point scale (0 = no or low occurrence, 3 = high occurrence). Each item relates to a specific behavioral or emotional episode (such as "*I feel tense or 'wound up'*") and the frequency of which it occurred in the past week. Participants can score anywhere 0-21 on either scale, with 0-7 indicating normal results, 8-10: mild, 11-14: moderate, and 15-21: severe. Anxiety and Depression subscales of the HADS have been reported to have high test-retest reliability (Spinhoven et al., 1997) and internal consistency across a number of different populations including individuals with TBIs (Boxley et al., 2016). For the current study the HADS was used to examine anxiety and depression as potentially confounding factors, as high levels have been found to impact social cognition (Cusi et al., 2012; Weightman, Air & Baune, 2014).

Interpersonal Reactivity Index (IRI)

The IRI is a 28-item scale developed by Davis (1980) to measure cognitive and emotional components of empathy. It contains four subscales each with seven items to measure: perspective taking (tendency to take the perspective of another), fantasy (how much participants relate to fictional characters), empathetic concern (measures feelings of sympathy for others), and personal distress (degree of anxiety and agitation in stressful interpersonal situations. Participants must rate their degree of fit with items on a 5-point Likert scale (A = '*does not describe me well'* to E = '*describes me very well'*). The IRI has good convergent validity (Davis, 1980), good test-retest reliability and high internal reliability within subscales (Pulos et al., 2004).

Social Emotional Questionnaire (SEQ)

The SEQ (Hornak et al. 2003), is a measure of social and emotional functioning developed for individuals with brain lesions. The questionnaire contains 30 items, of which nine are reverse scored and six are filler items. The SEQ has two versions; self and informant which contain the same items referring to the participant's behaviour, but described in a first and third person perspective, i.e. "*I notice when other people are happy" / "He/she notices when other people are happy")*. An increased discrepancy between participant and informant scores is indicative of poor self-awareness of social abilities. The questionnaire is scored on a 5-point Likert scale scoring system (1= strongly disagree, 5= strongly agree). The SEQ contains five subscales of Emotion Recognition (ER), Emotional Empathy (EE), Interpersonal Relationships, Public Behaviour, and Antisocial Behaviour. For the purpose of this study, the ER and EE sub-scales were used as measures of social cognition. The SEQ takes approximately 10 minutes to complete.

The Awareness of Social Inference Test Shortened (TASIT-S)

The TASIT-S (Honan et al., 2016) is an ecologically valid and objective measure of emotion perception and social cognition. The TASIT-S is comprised of three individual tests, each containing 30-60 second video vignettes depicting every day social interactions. The Emotional Evaluation Test (EET) consists of 10 items to assess emotion perception. Participants are required to answer what emotions were being displayed (happy, sad, anxious, revolt, surprise, anger or 'neutral'). The Social Inference (Minimal) Test (SIMT) consists of 9 items to measure comprehension of genuine and sarcastic interactions. The Social Inference (Enriched) Test (SIET; 9 items) measures the ability to understand sarcastic interactions that involve rich contextual cues and the ability to comprehend lies. Participants could answer

"*Yes/No/Don't Know*" to questions which referred to the emotional state, intentions, beliefs and feelings of the speaker. The TASIT-S has high item reliability with all subscale items having a reliability value of above .89 (Honan et al., 2016).

Sydney Psychosocial Reintegration Scale (SPRS)

The SPRS (Tate et al., 1999) is a 12-item scale that assesses psychosocial outcomes in terms of how individuals with ABIs participate in the community and how this may have changed as a result of an ABI. The SPRS uses self and informant versions, and contains three subscales containing 4 items to measuring work and leisure, interpersonal relationships and independent living skills. The SPRS is responded to on a 7 point Likert scale where 0 = *extremely* to 6 = *not at all*. Higher scores indicate better functioning and less negative change as a result of injury. Scores of 0-2 indicate major changes and poor outcomes, 3-4 indicate some change and limited outcomes, 5 and above indicate no significant life changes and good outcomes (Tate, 2011).

The SPRS takes approximately 10 minutes to complete. The SPRS has been validated among ABI populations (Kuipers, Kendall, Fleming, & Tate, 2004) and has strong inter-rater reliability, temporal stability and concurrent, construct and divergent validity (Tate et al., 2011).

Procedure

Ethics approval was obtained (HREC 15660 – see Appendix A). Eligible participants received an information sheet and consent form prior to testing; data collection only began once informed consent was obtained (see Appendix B). A medical release form was also presented to ABI participants of which they had the option of providing written consent for in the case of additional medical information being required (Appendix B). In order to maximize comprehension, testing and

consent information was presented verbally where required. Testing had the potential to cause minor discomfort such as fatigue and frustration. In order to minimize these effects, participants were informed they were free to take breaks when required. Recalling details about brain injuries has the potential to cause distress. Participants were reminded that they were free to withdraw at any point during the process and provided with contact information for a free counselling service if required.

Assessments were conducted on University of Tasmania Campuses, in the participant's home (in the presence of a TABIS case manager), or at TABIS or BIAT centers. Measures were completed in the following order: demographic questionnaire, and medical release form, HADS, TOPF, IRI, SEQ, TASIT-S. Only ABI participants completed the SPRS, and this was done prior to the TASIT-S. An informant for each ABI participant completed the relevant version of the SPRS and SEQ; informants for control participants completed the relevant version of the SEQ. The TASIT-S was presented on a laptop that participants could adjusted for volume, location and brightness. Participants had the option of pausing the video where extra time was required.

Completion of testing took approximately 80 minutes for ABI participants, 50 minutes for controls and 10 minutes for informants. Due to fatigue and concentration difficulties, three ABI participants completed testing in two separating sittings. Participants were debriefed following testing and thanked for their participation.

Design and Analysis

A cross sectional between groups design was used in analysing sex and group differences on social cognition and its relationship to psychosocial outcomes. A series of independent *t*-tests and Chi-square tests were conducted to compare

potential differences between ABI and control groups; males and females, on demographic measures of premorbid IQ (TOPF and education), age, depression and anxiety (see Table 3). Within the ABI group further independent *t*-tests were conducted to compare potential differences between ABI severity and years since injury.

To analyse sex differences between ABI and control participants on measures of social cognition, six 2 (Males vs Female) x 2 (ABI vs Control) factorial analyses of variance (ANOVA) were conducted. The dependent variables were scores on the IRI, EE and ER subscales of the SEQ (participant and informant), and EET, SIMT and SIET subscales of the TASIT-S. As an additional analysis, a further four ANOVAs were conducted on the TASIT-S to examine ability to detect sarcasm, sincerity and lies.

To determine the predictive utility of social cognition as a determinant of psychosocial functioning for males and females with ABIs, six hierarchical multiple regressions were conducted. Predictor variables were the IRI, EE and ER subscales of the SEQ (participant and informant), and subscales of the TASIT-S. The outcome variables were Work, Relationship and Living subscales of the SPRS.

As the sample size of the current study is underpowered for a regression analysis (Field, 2009; Green, 1992), rather than focusing on detecting significance, this analysis aims to be exploratory, with the objective of investigating the potentially predictive relationship between social cognitive measures and functional outcomes, and how this may differ on account of sex. Effect sizes of R^2 were therefore interpreted as a measure of practical significance (Lakens, 2013) in accordance with Ferguson (2009), in addition to measures of statistical significance.

Results

Statistical analysis was conducted using SPSS version 24. An alpha level of .05 was used to determine significance for all analyses. For comparison analyses, Cohen's *d* effect sizes were calculated and interpreted according to the following criteria; .20 for a small effect, .50 a moderate effect and .80 as a large effect (Cohen, 1992). Partial eta squared was calculated for ANOVAs and interpreted in accordance with Cohen's (1988) benchmarks to define small (0.01), medium (0.06), and large (0.14) effects. Correlations were interpreted as .1 for a small effect, .3 a medium effect and .5 as a large effect (Cohen, 1992). Effect sizes for regression models were calculated using R^2 and interpreted accordance with Ferguson's (2009) recommendations for clinical populations (.04 = recommended minimum effect; .25 = moderate effect; .64 = strong effect).

Data Screening

The data was screened to test the assumptions of each statistical analysis. For the *t*-tests, the data was examined for the presence of outliers, which were classed as scores greater than 3 SD above or below the mean (Tabachnick & Fidell, 2013). Outliers were replaced according to the winsorizing method (Field, 2011) which affect two data points on the SPRS (ABI group) and one on the IRI (control). The data was examined to ensure normality of distribution by a visual inspection of normal probability plots and histograms. Normative skew values were assessed according to the recommendations of Tabachnick and Fidell (2013), where by values outside the range $z = \pm 3.29$ were considered to be at least moderately skewed. The subscales of the SPRS were negatively skewed; the data was therefore reverse scored and a square root transformation was conducted. This transformation did not impact results and consequently the raw data was retained in the analysis for ease of

interpretation. Assumptions for regressions analysis including linearity, multicollinearity, independence of errors normality of residuals, were met.

As scores on the HADS for depression and TOPF significantly differed between ABI and control group, a series of ANCOVAs were conducted, covarying for these factors. No differences to significance levels from ANOVAs were apparent, and ANOVAs were therefore used to maintain power. A correlation analysis was conducted to determine whether there was a significant correlation between age and measures of social cognition. All measures were non-significant excluding the SIMT total. Age was therefore included as a covariate for this analysis.

As there is evidence that people with ABIs have impaired self-awareness (Spikeman et al., 2012), the discrepancy between self and informant scores on the SEQ total and EE and ER subscales were compared for the control and ABI groups using an independent samples *t*-test. There was found to be no significant differences on levels of self-awareness between ABI and control groups on the SEQ total, however for EE and ER subscales, ABI participants had significantly larger discrepancy scores than control participants (see Appendix C for output). Informant scores were therefore included in the analysis.

Group Comparison Analysis on Measures of Social Cognition.

In order to compare males and females in the ABI and control group on measures of social cognition, a series of 2 (Male vs Female) x 2 (ABI vs Control) factorial ANOVAs were conducted (see Figure 3 for descriptive statistics and Table 3 for inferential statistics). For the IRI, there was no main effect of condition. There was however, a main effect of sex, with females scoring significantly higher than males across both conditions, with a large effect size. For the SEQ subscales of EE and ER, there were no main effects of group or sex, and no interactions between

group and sex. However, deficits to self-awareness were apparent as discrepancy scores (between participant and informant) differed significantly between ABI and control groups on SEQ; EE and ER subscales. Consequently, informant scores were analysed and revealed a trend towards significance for the effect of sex on the ER, with a small to medium effect size. Additionally, for both ER and EE informant reports, there was a significant effect of condition, with medium to large effect sizes.

The results of the analysis for the TASIT-S revealed there to be a significant interaction between group and sex on all three subscales of the TASIT-S; for EET and SIET this was a large effect, for SIMT; a medium effect. Specifically, social cognitive ability was much more negatively affected by presence of an ABI for males, whereas ABI females did not perform any worse that control females. Further analysis into the sarcasm, sincerity and lies component of the TASIT-S, revealed there to be a significant interaction between sex and condition on the SIET for ability to detect sarcasm. The ABI group also performed significantly worse than controls on the SIET in regard to ability to detect lies.

These results support the hypothesis that sustaining an ABI will have more of a negative impact on social cognitive ability for males than females. Males performed worse than females on all measures of social cognition in the ABI group. This effect of sex was significant for the IRI, and the SEQ- ER informant scores revealed a trend towards this also. In addition, all three TASIT-S subscales also revealed a significant interaction between presence of an ABI and sex, further supporting this statement.

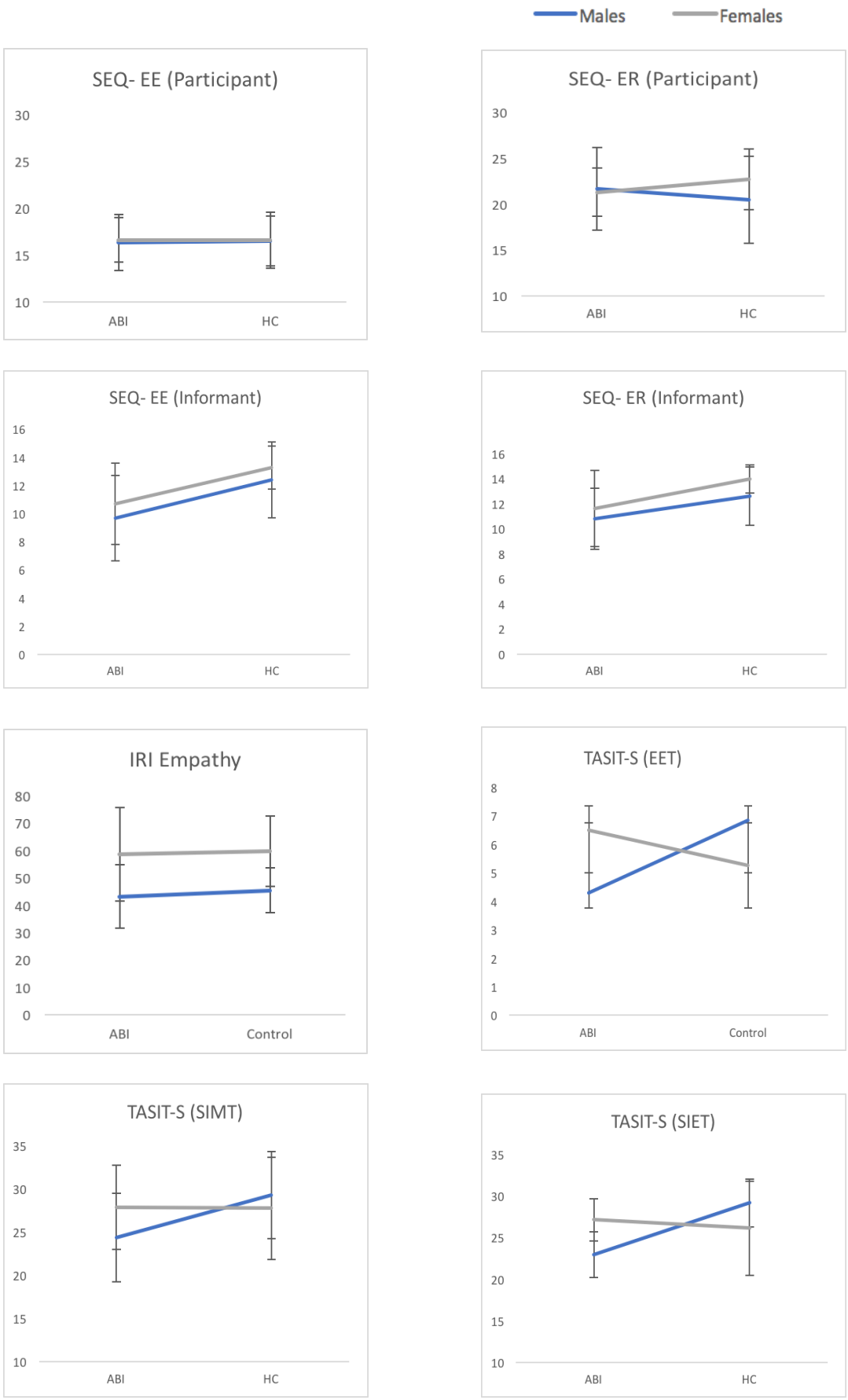
Table 3

Inferential Statistics from factorial ANOVAs: Males vs Females; ABI vs Controls

Measure		*F*	*p*	η_p^2
SEQ: EE (Participant)	Sex	.06	.801	.001
	Group	.01	.918	<.001
	Interaction	.02	.888	<.001
SEQ: ER (Participant)	Sex	.97	.328	.014
	Group	.01	.912	<.001
	Interaction	1.90	.175	.025
SEQ: EE (Informant)	Sex	2.13	.149	.030
	Group	17.57	<.001*	.205
	Interaction	.016	.900	<.001
SEQ: EE (Informant)	Sex	2.13	.149	.030
	Group	17.57	<.001*	.205
	Interaction	.016	.900	<.001
IRI	Sex	24.81	<.001*	.264
	Group	.319	.574	.005
	Interaction	.037	.848	.001
TASIT-S: EET	Sex	.48	.492	.007
	Group	2.12	.150	.030
	Interaction	17.68	<.001*	.204
TASIT-S: SIMT	Sex	.45	.506	.007
	Group	3.14	.081	.044
	Interaction	4.37	.040*	.060
TASIT-S: SIET	Sex	.451	.504	.007
	Group	9.28	.003*	.123
	Interaction	17.68	<.001*	.211

Note. * $p < .05$

Figure 3. ANOVAs Comparing Sex x Condition on Social Cognition



Predictive Value of Male and Female Social Cognition for Psychosocial Functioning

Hierarchical multiple regressions were performed on the ABI group to examine whether performance on measures of social cognition predicted psychosocial outcomes on the SPRS (Work and Leisure, Relationships and Living Skills) for males and females. All regressions contained the same hierarchical sequence; model 1 contained demographic variable of age, years since injury and estimated premorbid IQ; model 2 added the EET, SIMT and SIET subscales of the TASIT-S; model 3 added the IRI and SEQ subscales of EE and ER (participant and informant scores).

For males, the final regression model significantly predicted performance on all three SPRS subscales (Work and Leisure, $p = .031$; Relationships; $p = .011$; Living Skills, $p = .038$). The final model also accounted for significantly more variance in the outcomes measures of Work and Leisure (61%), Relationships (69%) and Living Skills (66%). Additionally, an estimate of effect size revealed there to be a strong association between the final model and all SPRS subscales for males (See Table 10). Finally, the SIMT subscale of the TASIT-S (objective measure) made a significant contribution to the predictive value of the final model for the Work and Leisure and Relationship subscales. The ER (Informant measures) and EE (participant) also made significant contributions to the Relationship and Living Skills subscales. For females, none of the regressions models significantly predicted performance on the SPRS- Work and Leisure, Relationships or Living Skills subscales. The variance accounted for by final model for females, was 36% for Work and Leisure, 46% for Relationships and 33% for Living Skills. Whilst none of the regression models significantly predicted psychosocial outcomes for females, the

study was underpowered for a regression analysis. An estimate of effect size revealed there to be a strong association between the final model and the Living Skills subscale (see Table 10). Additionally, all measures of the TASIT-S in the final model on the Living Skills subscale, had moderate sized effects. These findings indicate that perhaps the low sample size of the study (including less females than males) may have masked an effect for females.

Overall, the results support the hypothesis that for males, social cognitive ability would be impaired to the extent that it will predict psychosocial functioning (work and leisure, relationships and living skills); whereas for females, deficits to social cognition would not predict psychosocial functioning.

Table 4

Hierarchical Regression for the Prediction of SPRS Work and Leisure Subscale from Measures of Social Cognition for Males

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**.019**				
(Constant)	26.923	13.318			.061
Age	-0.023	0.169	-.039	-.048	.895
Premorbid IQ	-0.005	0.147	-.01	-.007	.975
Years Since Injury	-0.064	0.128	-.13	-.13	.626
Model 2 (ΔR^2)	**.241**				
(Constant)	-5.428	24.917			.831
Age	0.041	0.21	.071	-.048	.849
Premorbid IQ	0.003	0.143	.006	-.007	.984
Years Since Injury	-0.011	0.138	-.022	-.13	.939
TASIT-S: EET	-1.581	1.305	-.444	-.11	.249
TASIT-S: SIMT	0.898	0.532	.56	.329	.117
TASIT-S: SIET	0.445	0.772	.164	.167	.575
Model 3 (ΔR^2)	**.613**				
(Constant)	-35.352	16.285		.067	.067
Age	0.053	0.132	0.092	-.048	.701
Premorbid IQ	-0.016	0.091	-0.033	-.130	.863
Years Since Injury	0.076	0.082	0.154	.920	.388
TASIT-S: EET	-1.192	0.897	-0.334	-.110	.226
TASIT-S: SIMT	0.826	0.301	0.515	.329	.029*
TASIT-S: SIET	0.556	0.527	0.205	.167	.327
SEQ: ER (Participant)	0.026	0.347	0.016	.410	.942
SEQ: EE (Participant)	1.256	0.55	0.492	.573	.057
IRI: Empathy	-0.191	0.131	-0.274	-.049	.190
SEQ: ER (Informant)	1.988	0.696	0.588	.530	.240
SEQ: EE (Informant)	-0.852	0.618	-0.33	-.060	.211

Note. * $p < .05$

Table 5

Hierarchical Regression for the Prediction of SPRS Relationships Subscale from Measures of Social Cognition for Males

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**.029**				
(Constant)	25.847	12.146			.050*
Age	0.049	0.155	.092	.03	.757
Premorbid IQ	-0.054	0.134	-.119	-.048	.694
Years Since Injury	-0.07	0.116	-.156	-.133	.558
Model 2 (ΔR^2)	**0.186**				
(Constant)	1.322	23.516			.956
Age	0.08	0.198	.152	.03	.693
Premorbid IQ	-0.047	0.135	-.105	-.048	.732
Years Since Injury	-0.019	0.13	-.043	-.133	.885
TASIT-S: EET	-1.433	1.231	-.439	-.176	.267
TASIT-S: SIMT	0.698	0.502	.475	.223	.190
TASIT-S: SIET	0.356	0.728	.143	.119	.634
Model 3 (ΔR^2)	**.693**				
(Constant)	-29.747	12.677			.051
Age	0.114	0.103	0.216	.030	.303
Premorbid IQ	-0.041	0.07	-0.091	-.133	.582
Years Since Injury	0.010	0.064	0.022	-.048	.879
TASIT-S: EET	-0.771	0.699	-0.236	-.176	.306
TASIT-S: SIMT	0.577	0.234	0.392	.223	.043*
TASIT-S: SIET	0.617	0.41	0.248	.119	.176
SEQ: ER (Participant)	-0.001	0.27	-0.001	.475	.997
SEQ: EE (Participant)	1.327	0.428	0.568	.659	.017*
IRI: Empathy	-0.147	0.102	-0.23	-.004	.194
SEQ: ER (Informant)	1.821	0.542	0.587	.507	.012*
SEQ: EE (Informant)	-1.079	0.481	-0.456	-.131	.060

Note. * $p < .05$

Table 6

Hierarchical Regression for the Prediction of SPRS Living Skills Subscale from Measures of Social Cognition for Males

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**.017**				
(Constant)	21.615	10.723			.062
Age	0.037	0.136	.08	.005	.791
Premorbid IQ	-0.06	0.118	-.152	-.106	.619
Years Since Injury	-0.016	0.103	-.041	-.013	.878
Model 2 (ΔR^2)	**0.186**				
(Constant)	3.024	20.792			.887
Age	0.021	0.175	.045	.005	.906
Premorbid IQ	-0.053	0.119	-.134	-.106	.664
Years Since Injury	0.044	0.115	.112	-.013	.709
TASIT-S: EET	-1.535	1.089	-.535	-.187	.184
TASIT-S: SIMT	0.515	0.444	.399	.183	.269
TASIT-S: SIET	0.365	0.644	.167	.104	.582
Model 3 (ΔR^2)	**.660**				
(Constant)	-19.871	13.569			.186
Age	0.093	0.11	0.200	.005	.428
Premorbid IQ	-0.015	0.075	-0.039	-.013	.846
Years Since Injury	-0.006	0.068	-0.014	-.106	.938
TASIT-S: EET	-0.652	0.748	-0.227	-.187	.412
TASIT-S: SIMT	0.394	0.251	0.306	.183	.160
TASIT-S: SIET	0.743	0.439	0.341	.104	.135
SEQ: ER (Participant)	-0.261	0.289	-0.198	.291	.398
SEQ: EE (Participant)	1.23	0.459	0.600	.562	.031*
IRI: Empathy	-0.159	0.109	-0.284	-.138	.188
SEQ: ER (Informant)	1.71	0.58	0.629	.469	.021*
SEQ: EE (Informant)	-1.195	0.515	-0.576	-.197	.053

Note. * $p < .05$

Table 7

Hierarchical Regression for the Prediction of SPRS Work and Leisure subscale from Measures of Social Cognition for Females

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**0.138**				
(Constant)	19.041	8.332			.041
Age	0.007	0.176	.011	.075	.97
Premorbid IQ	0.081	0.095	.266	.115	.41
Years Since Injury	-0.16	0.122	-.385	-.277	.214
Model 2 (ΔR^2)	**0.126**				
(Constant)	7.131	25.113			.783
Age	-0.028	0.197	-.046	.075	.89
Premorbid IQ	0.085	0.108	.278	.115	.452
Years Since Injury	-0.113	0.158	-.273	-.277	.493
TASIT-S: EET	1.633	1.875	.388	.430	.407
TASIT-S: SIMT	-0.019	0.549	-.014	.347	.973
TASIT-S: SIET	-0.01	1.111	-.004	.305	.993
Model 3 (ΔR^2)	**0.362**				
(Constant)	-1.471	44.144			.975
Age	-0.312	0.349	-0.75	.075	.422
Premorbid IQ	0.159	0.171	0.519	.430	.407
Years Since Injury	-0.229	0.248	-0.373	.115	.409
TASIT-S: EET	0.496	2.498	0.118	.347	.852
TASIT-S: SIMT	-0.869	0.938	-0.664	.305	.407
TASIT-S: SIET	1.067	1.385	0.43	.116	.484
SEQ: ER (Participant)	1.255	1.132	0.525	-.359	.330
SEQ: EE (Participant)	-1.354	1.672	-0.505	-.413	.463
IRI: Empathy	-0.065	0.198	-0.175	.446	.760
SEQ: ER (Informant)	0.322	2.34	0.155	.116	.897
SEQ: EE (Informant)	0.998	2.388	0.456	-.277	.697

Note. * $p < .05$

Table 8

Hierarchical Regression for the Prediction of SPRS Relationships Subscale from Measures of Social Cognition for Females

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**.085**				
(Constant)	19.722	5.042			.002
Age	0.016	0.106	.046	.114	.879
Premorbid IQ	0.045	0.058	.252	.164	.448
Years Since Injury	-0.063	0.074	-.256	-.151	.414
Model 2 (ΔR^2)	**.029**				
(Constant)	13.706	16.193			.419
Age	0.004	0.127	.012	.114	.974
Premorbid IQ	0.036	0.07	.202	.164	.615
Years Since Injury	-0.039	0.102	-.158	-.151	.715
TASIT-S: EET	-0.326	1.209	-.132	.083	.794
TASIT-S: SIMT	0.155	0.354	.202	.268	.672
TASIT-S: SIET	0.136	0.717	.093	.135	.853
Model 3 (ΔR^2)	**.465**				
(Constant)	11.591	27.553			.696
Age	-0.107	0.218	-0.438	-.151	.649
Premorbid IQ	0.082	0.107	0.458	.164	.485
Years Since Injury	-0.145	0.155	-0.404	.114	.401
TASIT-S: EET	-0.988	1.559	-0.4	.083	.561
TASIT-S: SIMT	-0.290	0.585	-0.376	.268	.647
TASIT-S: SIET	0.780	0.864	0.535	.135	.418
SEQ: ER (Participant)	0.433	0.706	0.308	.028	.573
SEQ: EE (Participant)	-1.103	1.044	-0.7	-.529	.350
IRI: Empathy	0.019	0.123	0.086	-.353	.887
SEQ: ER (Informant)	0.566	1.461	0.464	.377	.718
SEQ: EE (Informant)	0.305	1.49	0.237	.092	.848

Note. * $p < .05$

Table 9

Hierarchical Regression for the Prediction of SPRS Living Skills Subscale from Measures of Social Cognition for Females

	Unstandardized Coefficients				
	B	SE (B)	β	*r*	*p*
Model 1 (ΔR^2)	**.081**				
(Constant)	22.483	5.669			.002
Age	0.091	0.119	.225	.215	.461
Premorbid IQ	0.002	0.065	.011	.011	.974
Years Since Injury	-0.053	0.083	-.192	-.171	.539
Model 2 (ΔR^2)	**.307**				
(Constant)	1.528	15.09			.922
Age	0.035	0.118	.087	.215	.772
Premorbid IQ	0.001	0.065	.007	.011	.984
Years Since Injury	0.006	0.095	.023	-.171	.948
TASIT-S: EET	0.972	1.127	.35	.578	.411
TASIT-S: SIMT	0.083	0.33	.096	.427	.807
TASIT-S: SIET	0.381	0.668	.233	.559	.582
Model 3 (ΔR^2)	**.331**				
(Constant)	-4.226	25.216			.875
Age	-0.082	0.199	-0.3	-.171	.701
Premorbid IQ	0.051	0.098	0.254	.011	.629
Years Since Injury	-0.095	0.142	-0.236	.215	.539
TASIT-S: EET	0.089	1.427	0.032	.578	.953
TASIT-S: SIMT	-0.415	0.536	-0.481	.427	.482
TASIT-S: SIET	1.093	0.791	0.668	.559	.239
SEQ: ER (Participant)	0.527	0.647	0.335	.021	.460
SEQ: EE (Participant)	-0.736	0.955	-0.417	-.352	.484
IRI: Empathy	-0.033	0.113	-0.134	-.454	.787
SEQ: ER (Informant)	0.547	1.337	0.4	.601	.703
SEQ: EE (Informant)	0.32	1.364	0.222	.334	.826

Note. * $p < .05$

Table 10

Estimates of Effect Size (R^2) For Regression Models

	Males	Females
Work and Leisure		
Model 1	.019	.138
Model 2	.260*	.265*
Model 3	.873**	.627*
Relationships		
Model 1	.029	.085
Model 2	.216	.114
Model 3	.908**	.579*
Living Skills		
Model 1	.017	.081
Model 2	.203	.389*
Model 3	.864**	.720**

Note. * Moderate Effect (Ferguson, 2009)

Note. ** Strong Effect (Ferguson, 2009)

Discussion

The aim of this study was to investigate the potential impact of sex differences on social cognition following ABI, and the predictive value of social cognition on psychosocial outcomes. Based on previous research regarding a female advantage in social cognition in healthy populations (Collingnon et al., 2010; Krach et al., 2009; Weisenbach et al., 2014), and for overall social outcomes after ABI (Farace & Alves, 2000), it was hypothesised that sustaining an ABI would have more of a negative impact on social cognitive ability for males than for females. This would be demonstrated by ABI males experiencing significantly lower scores on self-report, informant-report and objective measures of social cognition than male controls; whereas it was predicted that females with ABIs would display similar scores on the same measures of social cognitive to female controls. It was also hypothesised that for males, social cognitive ability would be impaired to the extent that it would predict psychosocial function (i.e. work and leisure, relationships and living skills); whereas for females, deficits to social cognition would not predict psychosocial functioning following ABI.

The results of the study supported the first hypothesis. There was a significant interaction between sex and presence of an ABI on all three subscales scores of the TASIT-S. This indicates that presence of an ABI affected males and females' social cognitive ability differently. Specifically, for males, social cognitive ability was much more negatively affected by presence of an ABI, whereas females did not experience this decline in performance between control participants to ABI participants. ABI males also performed worse than both ABI females and controls on all measure of social cognition. This difference between ABI males and ABI females was significant on all measures of social cognition excluding the participant SEQ:

ER and ER, however for informant measures of the SEQ: ER, there was a trend towards significance.

Self-awareness is known to be reduced in ABI populations (Niemeier et al., 2014; Ownsworth & Fleming, 2005). Deficits to self-awareness were apparent in the current study as discrepancy scores (between participant and informant) differed significantly between ABI and control groups on SEQ; EE and ER subscales. The presence of a significant interaction on all subscales of the TASIT-S where none others were apparent in self-report measures, may indicate that the TASIT-S, an objective measure, provides a more accurate indication of social cognition (Honan et al., 2016; Temkin et al., 2009). When informant scores on the SEQ measures were analysed, it was revealed that for SEQ-ER scores, there was a significant effect of condition and the main effect of sex was trending towards significance. For SEQ-EE, there was also a significant effect of condition. These findings are consistent with the pattern of results found in the TASIT-S, where by ABI males performed worse than both ABI females and controls. Overall this suggests that the measures of social cognition that do not rely on self-report (TASIT-S and SEQ informant reports), may be a more accurate representation of social cognitive ability. It light of this, the results of the study reveal that for males (unlike females), presence of an ABI is detrimental to social cognitive ability.

The findings that ABI males performed worse than both controls and ABI females, whilst ABI females to performed similar to control females, supported previous findings by Rigon et al (2016), who found the same effect in TBI individuals on measures of emotion perception. This therefore provides evidence to suggest that perhaps ABIs have more of a negative effect on social cognitive ability for males than for females. This also suggests that sustaining an ABI may accentuate

baseline sex differences, whereby not only do males demonstrate poorer social cognition in healthy populations (Collingnon et al., 2010; Krach et al., 2009; Weisenbach et al., 2014), they may also experience greater reduction of social cognitive function than females following an ABI. The additional analysis examining ability to detect sarcasm, sincerity and lies on the TASIT-S revealed a significant interaction between sex and condition on the SIET for sarcasm detection. ABI participants also performed significantly worse than controls on the SIET in ability to detect lies. A lack of significant differences on sincerity measures may reflect ceiling effects in that the content of these interactions were perhaps more straightforward and easier to understand. These finding contribute to the overall pattern of results in regard to the individual variation seen between males and females following an ABI, and suggest that deficits in sarcasm and lie detection, may have contributed to the results found in all TASIT-S subscales; highlighting the elements within social cognition that are particularly challenging for ABI populations.

The presence of a significant interaction between sex and ABI on measures of social cognition, has implications for the theories underlying sex differences in ABIs. Niemeier et al. (2007) suggest that findings such as these support hypotheses regarding the hormonal neuroprotective effects of progestogen which may underlie a female advantage in social cognition (Gibson, et al., 2008). However, as this study does not directly compare males and females in regard to outcomes, the results provide limited support. The results of the current study also hold implications for theories regarding social cognition. Research is only just beginning to uncover and understand the information processing requirements of social cognition. Whether social cognition encompasses a combination of processes specific to social

cognition, along with more generic cognitive, memory and executive functions, is debated. As the current study did not analyse these generic functions separately, it is unclear as to if, or how much these generic factors underlay the sex differences found in the current study. However, previous research suggest that females outperform males in language, attention and visual and working memory tasks (Moore et al., 2010; Ratcliff et al., 2007). In terms of the current study, this may provide support for the presence of both distinct and generic processes of cognition, and suggest that the female advantage in social cognition was a result of a superior performance on the generic processes involved in social cognition.

This study also provides insight and potentially support the proposition that social cognition encompasses three discrete processes (McDonald, 2013). In accordance to this theory, the processing requirements of the TASIT-S were much more complex than that of the SEQ and IRI, and required use of all three of these processes of social cognition: perception, evaluation and interpretation, and effortful regulation of responses and contextualization. The SEQ and IRI in contrast however, are both mainly linked to this third element, in terms of their self-awareness and reflection requirements. The findings of a significant interaction between sex and ABI for all three subscales of the TASIT-S, where there were none for the SEQ or IRI, provides support for the distinction between these three elements of social cognition and suggests that perhaps the processes required solely for the TASIT-S, are more vulnerable to the effects of an ABI and/or more vital for effective social cognition for ABI males.

The second hypothesis, that for males, social cognitive ability would predict psychosocial functioning; whereas for females, deficits to social cognition would not predict psychosocial functioning, was also supported. For males, the final regression

model with all measures of social cognition included, significantly predicted psychosocial functioning on all three SPRS subscales (Work and Leisure, Relationships and Living Skills). The final model also accounted for significantly more variance in all of these outcomes measures for males only. Additionally, an estimate of effect size revealed there to be a strong association between the final model and all SPRS subscales, again, only for males. For females, none of the regressions models significantly predicted performance on the SPRS; Work and Leisure, Relationships or Living Skills subscales. However, an estimate of effect size did reveal there to be a strong association between the final model and the Living Skills subscale for females. This suggests that perhaps social cognitive ability, whilst not affected by the presence of an ABI, may still predict psychosocial outcomes in terms of living skills. However, this effect may have been masked on account of the current study not meeting the requirement of power for a regression analysis. It is also important to note, that the impact of self-awareness on self-report measures was also demonstrated in the results of the regression analysis as both the TASIT-S-SIMT (objective measure) and SEQ-ER (informant measures) made a significant contribution to the predictive value of the final model for two of the functional outcomes subscales, although SEQ-EE (participant) also made two significant contributions.

The results of the current study are consistent with previous research findings regarding the predictive value of social cognition (Ubukata et al., 2014) and indicates support for research that has identified sex differences in psychosocial outcomes (e.g. Farace & Alves, 2000; Niemeier et al., 2007). In addition, the results of the study confirm the proposal by Adolphs (2003) regarding the importance of social

cognition as an effective and appropriate integration and participation in society, as deficits to social cognition (for males) were predictive of psychosocial impairment.

While males experienced poorer social cognitive ability than females and this was predictive of their psychosocial functioning; it remains unclear as to whether poorer social cognitive ability predicts poorer psychosocial outcomes for males as compared to females. Previous research has demonstrated mixed findings in regard to sex differences in psychosocial outcomes. Mukherjee et al (2003) found that males fared better than females in regard to psychosocial outcomes and Niemeier et al. (2007), found that males fared better than women in terms of functional independence. According to these findings it may be that while social cognitive ability predicts psychosocial functions for males, the effects of this are minimal, whereas for females, other factors have more of a detrimental effect to psychosocial outcomes for females. For example, females with TBIs have been found to be more susceptible to depression, posttraumatic stress disorder, relationship problems and low self-esteem (Reichard, Langlois, Sample, Ward, & Pickle-simeral., 2007). Females with an ABI are also less likely to have a partner than males (de Guise et al., 2014), decreasing their opportunity for support. These factors all have the potential to negatively impact psychosocial outcomes for females.

Research has also demonstrated that females experience better recovery (Gibson et al., 2008) and more specifically, an advantage for social and relationship outcomes after TBI (Farace & Alves, 2000). Niemeier et al. (2007) also found evidence to suggest females had a superior ability to self-regulate and were more flexible in their responses to a changing environment. These findings fit more intuitively with the results of the current study and suggest that the male

disadvantage for social cognitive ability post ABI, predicts worse psychosocial outcomes as compared to females.

However, research also exists that has failed to find any differences in regard to psychosocial outcomes of employment (Bazarian et al, 2010; Cancelliere, Donovan, & Cassidy, 2016; Farace & Alves, 2000), return to regular activities (Bazarian et al., 2010) functional independence and social interaction (de Guise et al., 2014). These mixed findings, may come down to the large variety of measures used (Rigon et al., 2016). Additionally, these findings come from a limited pool of research. The review by Cancelliere et al (2016) identifying that only 7% of 200+ studies stratified data by sex. Within this, the number of studies that explore psychosocial outcomes is even smaller. It is therefore difficult to draw any conclusions regarding sex differences in psychosocial outcomes. However, based on the findings from the current study of sex differences in social cognitive ability and sex differences in the predictive value of this for psychosocial outcomes, it suggests that within psychosocial functioning, there appears to be some evidence of sex differences in that impairments to social cognition may in part explain psychosocial functioning for males.

Strengths and Limitations

There were a number of strengths in the current study. Only one study by Ubukata et al. (2014) has examined the how social cognitive ability may predict functional outcomes in ABI populations, and it failed to find any consistent results. In comparison to Ubukata et al., the current study utilized a larger sample size, included a control group and multiple reporting measures (self, informant and objective) and analysed males and females separately. In doing so, the current study was able to demonstrate that social cognitive ability was predictive of functional

outcomes, and that sex impacted this. The lack of a control group is also a limitation of many ABI studies (Temkin et al., 2009). The current study highlights the importance of a control group in order to conclude that sex differences in social cognitive impairment following an ABI are not just a reflection of pre-existing differences (which are known to occur; e.g. Collingnon et al., 2010). In addition, the use of multiple measures (i.e. self-report, informant report and objective report) is also lacking in ABI literature, despite the prevalence of self-awareness impairments in ABI populations (McDonald, 2013). The current study has employed these measures in in order to provide the most accurate measurement of social cognition.

Similar to the majority of research with clinical populations, this study was hampered by a small sample size. However, in comparison to similar clinical studies (e.g. Ubukata et al., 2014) this sample was relatively sizeable (n = 22 vs n = 39) and may therefore be considered a strength of the study. Regardless of this, the study was underpowered for a regression analysis and may have resulted in a failure of some analyses to reach statistical significance where there was in fact, an effect.

As with all ABI research, this study is hindered by the intrinsic complexity of ABI pathology. No two ABI cases have identical deficits. This limitation was accentuated by the fact that this study was conducting using participants with all types of ABIs rather than focusing on a specific subtype. Even within the same subtype of ABI, there was variability in its characteristics (e.g. severity, time since injury, location of damage). However, this limitation is common in research on such populations (Temkin et al., 2009). In addition, the exclusion criteria for ABI participants in the present study was minimal. This resulted in the inclusion of a number of characteristics which may have had the potential to impact results (e.g. amount of rehabilitation, medication usage, presence of neurological and psychiatric

conditions). Research has demonstrated psychiatric conditions such as depression do have the potential to affect social cognitive performance (Weightman, Air, & Baune, 2014). However, the current study conducted an analysis covarying for depression and found no significant differences.

Implications and Future Research

The findings from the current study provide valuable information in regard to research and rehabilitation in ABI populations by shedding light on the individual variability that is seen in psychosocial functioning following an ABI. Through the identification of social cognition and sex as factors predictive of psychosocial functioning, it is evident that future research would benefit from analysing males and females separately or by including sex as a covariate (Farace & Alves, 2000; Rigon et al., 2016). Rehabilitation programs would also benefit from recognising these differences and treating males and females accordingly.

Future research should aim to examine the potential source of disparity identified between males and females in social cognitive functioning. There are a number of potential reasons why disparities may exist between the sexes in social cognition. By investigating the interaction between sex and social cognition at various points along ABI recovery, it may help shed light on the source of this effect. Whether it is a result of hormonal neuroprotection in the form of progesterone which is hypothesised to underlie a gender advantage for females (Gibson, et al., 2008; Stein & Wright, 2010; Stein, 2013); differing executive functioning which may impact aspects of social cognition and is said to interact with sex hormones; oestrogen and testosterone (Upadhayay & Guragain, 2014). Explanations may also refer to gender role expectations and environmental influences (Niemeier et al., 2014; Geary, 2006). Finally, these differences may also be attributed to differing

brain structure related differences (Niemeier et al., 2014; Weisenbach et al., 2014). Further analysis of the components that make up social cognition would also be beneficial in order to gain a deeper understanding of the sex differences that were apparent in this study.

Clarification of whether these sex differences demonstrated in social cognition in the current study translate to sex differences psychosocial outcomes is also important and has not yet been investigated (Farace & Alves, 2000). In doing so, researchers should recognise and account for a number of variable factors such as time since injury and the impact of hormones as potentially impacting any differences seen in functional outcomes between the sexes. Slewa-Younan et al. (2008) in their literature review found that studies investigating functional outcomes, noted an advantage for males when examining functioning 3 – 18 months post injury, whilst studies examining outcomes 7 – 24 years post injury found an advantage for females. This suggests that perhaps the female advantage is most apparent over a longer term when factors such as psychosocial influences begin to have an effect. In addition, age may have a considerable affect as Slewa-Younan et al. (2008) found there to be no sex differences in outcomes in studies involving younger TBI participants, but when investigating older TBI participants, older females (post menopause) were found to have worse outcomes. This may be a result of hormones such as progesterone and oestrogen which can impact brain injury recovery (Stein, 2005). The mixed results seen in many studies analysing sex differences in outcomes post ABI, may have occurred on account of a lack of consistency across these potential influencing variables. Similarly, the variety of different outcome measures that are used (Rigon et al., 2016), may also prevent a clear effect of sex from becoming apparent. Future research should aim to control for

these factors in order to obtain a true depiction of sex differences in psychosocial outcomes.

Finally, future studies may benefit from exploring the role of self-awareness as a predictor of psychosocial functioning, as the discrepancy seen between participant and informant in the current study's results supports previous research in the area and highlights the prevalence of this issue. In light of these findings, it is also recommended that future studies conducting research on ABI populations employ objective measure to control for these deficits.

Conclusions

The results of the current study suggest that presence of an ABI is much more detrimental to social cognitive performance for males than for females; consistent with the pattern of results seen in previous research (Rigon et al., 2016). The predicative capability of social cognition for males' psychosocial functioning following an ABI, suggests that psychosocial outcomes are in part driven by sex differences in social cognition. By clarifying the role of these factors in regard to psychosocial outcomes, the results of this study may inform future ABI research and allow for stronger, clearer findings. These findings not only allow for the identification of individuals at risk of experiencing deficits to psychosocial outcomes, but in also demonstrate the importance of considering and recognizing both the impact of social cognitive impairment, and the distinction between males and females in research and rehabilitation with ABI populations.

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Appendix A

Ethics Approval

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
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Katherine.Shaw@utas.edu.au

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

2 May 2016

Ms Christine Padgett
Division of Psychology
University of Tasmania

Student Researcher: Madelaine Lodge

Sent via email

Dear Ms Padgett

Re: FULL ETHICS APPLICATION APPROVAL
Ethics Ref: **H0015660 - Social Cognition as a Predictor of Functional Outcomes After Acquired Brain Injury**

We are pleased to advise that the Tasmania Social Sciences Human Research Ethics Committee approved the above project on 29 April 2016.

This approval constitutes ethical clearance by the Tasmania Social Sciences Human Research Ethics Committee. The decision and authority to commence the associated research may be dependent on factors beyond the remit of the ethics review process. For example, your research may need ethics clearance from other organisations or review by your research governance coordinator or Head of Department. It is your responsibility to find out if the approval of other bodies or authorities is required. It is recommended that the proposed research should not commence until you have satisfied these requirements.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.

5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**

6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Katherine Shaw
Executive Officer
Tasmania Social Sciences HREC

Appendix B

Participant Documentation

Social Functioning and Acquired Brain Injury

Information sheet for participants

1. Invitation

We would like to invite you to participate in a study examining social functioning and acquired brain injury. The study is being conducted by Ms Mikalha George, as part of her honours thesis, and Dr Christine Padgett, who is a lecturer at the School of Medicine (Psychology) at the University of Tasmania.

2. What is the purpose of this study?

The aim of this study is to investigate how well someone with a brain injury can understand the way other people think and feel. We would like to see how important this is for the person to be able to go back to doing the same things as they did before the injury.

3. Why have you been invited to participate?

For this experiment, we are looking for people aged over 18 years old with an acquired brain injury. You have been invited to participate because you are involved with the Brain Injury Association of Tasmania (BIAT)..

4. What will you be asked to do?

You will be asked some questions about your injury, and you will also be given a short word-reading test. We will also ask you to complete some questionnaires about how well you understand what other people might be feeling or thinking. You'll also be asked some questions to see what (if any) changes have occurred in your daily activities since you had your brain injury. This should take around forty-five minutes to complete.

5. Are there any possible benefits from participation in this study?

The study does not provide you with any direct benefits. The results of this study may benefit the wider community with a better understanding of everyday functioning after a brain injury.

6. Are there any possible risks from participation in this study?

If you choose to participate, we will ask you questions about your brain injury. We do not expect this to be upsetting, but if this causes you any distress, you are free to withdraw at any time. There are no other risks associated with this study.

Social Cognition and Acquired Brain Injury

Information sheet for participants

Invitation

We would like to invite you to participate in a study examining social functioning and acquired brain injury. The study is a partial fulfillment of an honours degree for Mikalha George under the supervision of Christine Padgett, from the School of Psychology at the University of Tasmania.

What is the purpose of this study?

The experiment is examining social functioning in individuals with acquired brain injuries. These results will be compared to a sample of participants without an acquired brain injury to determine the social implications associated with acquired brain injuries. For example, it will address functioning in daily life, such as social interaction patterns and changes in activities due to their injury.

Why have you been invited to participate?

For this experiment, we are looking for people aged over 18 years old without history of an acquired brain injury, so we can compare test results of participants with acquired brain injuries to a healthy population.

We are looking for participants without a diagnosed psychiatric condition, such as schizophrenia and bipolar disorder.

What will you be asked to do?

We will also ask you to complete some questionnaires about how well you understand what other people might be feeling or thinking, and you will also be given a short word-reading test. These will help us compare differences on these measures between people who have not had a brain injury and those who have experienced a brain injury.

The activities should take around forty-five minutes to complete.

Are there any possible benefits from participation in this study?

The study does not provide any benefits directly to you, however the results will contribute knowledge to the area of social functioning and acquired brain injury, which may provide better understanding on the daily lives of those living with an acquired brain injury.

Are there any possible risks from participation in this study?

There are no identifiable risks in this study.

What if you change my mind during or after the study?

You are free to withdraw from this study at any time. You do not need to provide an explanation, and there are no consequences if you choose to withdraw. If at any stage you feel uncomfortable, you may withdraw from the study, there are no consequences

University of Tasmania

Participant Consent Form (ABI Version v2), 17/5/2017

Social Functioning and Acquired Brain Injury

For participants and guardians (if applicable)

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves a variety of questionnaires and scales, where I have to think about my day to day functioning and social interaction. I understand that these tasks will take around forty-five minutes to complete.
5. I understand that a family member or someone who I know well will also be asked to complete some questionnaires relating to my day to day functioning and social interaction.
6. I understand that my participation in this study involves discussing detail about my acquired brain injury. If this causes me any distress I am able to contact a free counselling service if I wish to use them. I also understand that there are no other foreseeable risks associated with my participation.
7. I understand that all research data will be securely stored by the University of Tasmania for five years after the publication of the study's results. All data will then be destroyed
8. Any questions that I have asked have been answered to my satisfaction.
9. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
10. I understand that the results of the study will be published in a manner where I cannot be identified as a participant.
11. I understand that my participation is voluntary and that I may withdraw at any time without any consequences, and I may request that any data I have supplied be withdrawn from the research until September 2017.

Please tick the appropriate box for each question below. Please note that you do not need to agree to either of the below in order to participate in this study:

1. I give permission for my test results to be used in future research.

   Yes ☐ No ☐
2. I give permission to be contacted for opportunities to participate in future research.

   Yes ☐ No ☐

University of Tasmania

Participant Consent Form, (control version), 17/5/2017

Social Functioning and Acquired Brain Injury

For participants

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves a variety of questionnaires and scales, where I have to think about my day to day functioning and social interaction. I understand that these tasks will take around forty-five minutes to complete.
5. I understand that a family member or someone who I know well will also be asked to complete some questionnaires relating to my day to day functioning and social interaction.
6. I understand that there are no foreseeable risks associated with my participation.
7. I understand that all research data will be securely stored by the University of Tasmania for five years after the publication of the study's results. All data will then be destroyed after the five years.
8. Any questions that I have asked have been answered to my satisfaction.
9. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
10. I understand that the results of the study will be published in a manner where I cannot be identified as a participant.
11. I understand that my participation is voluntary and that I may withdraw at any time without any consequences, and I may request that any data I have supplied be withdrawn from the research until September 2017.

Please tick the appropriate box for each question below. Please note that you do not need to agree to either of the below in order to participate in this study:

1. I give permission for my test results to be used in future research.

   Yes ☐ No ☐

2. I give permission to be contacted for opportunities to participate in future research.

   Yes ☐ No ☐

   If yes, I understand that my contact details will be kept on a confidential password protected file.

University of Tasmania
Version 2, 10/3/2016

Demographic Questionnaire

Participant ID: _____ Date tested: ___/___/_____

DOB: ___/___/_____ Sex: Male / Female

Highest level of education completed: _____

Do you have a legal guardian: Yes / No

Date of accident: ___/___/_____

Cause of accident: _____

Any loss of consciousness, if yes, for how long: _____

Any post traumatic amnesia, if yes, for how long: _____

Any past or present medical conditions: _____

Any past or present mental illness: _____

Any diagnosed neurological conditions: _____

Hours before your injury, had you been using illicit drugs? If yes, what type?

_____

Have you used any illegal or legal drugs in the past week that could impact your test scores?

_____

Did you have any treatment or rehabilitation from your injury, if yes what type?

_____

How long did you access this treatment? _____

What medications are you currently prescribed or taking?

Medication	Dose	Reason

University of Tasmania
Version 1, 10/3/2016

Demographic Questionnaire - Control

Participant ID: _____ Date tested: ___/___/_____

DOB: ___/___/_____ Sex: Male / Female

Highest level of education completed: _____

Any loss of consciousness, if yes, for how long: _____

Any physical or mental illness that could impact testing: Yes / No

Have you had any illegal or legal drugs (alcohol included) in the last week, which may impact your test performance? _____

_____

Appendix C

Additional Tables

Participant Demographic Characteristics: Males vs Females

Demographics	Males *M / n (SD / %)*	Females *M / n (SD / %)*	t / X^2	*p*	Cohens d/ Cramer's V
Age	47.33 (12.20)	45.16 (14.44)	.695	.489	.16
Premorbid IQ	95.69 (15.88)	103.81(17.60)	-2.03	.047	. 48
Education Level					
< Year 10	4	1			
Year 10-12	16	12			
Tafe	14	7			
University	7	11	4.914	.178	.178
HADS Anxiety	7.43 (4.67)	7.55 (4.54)	-0.11	.913	0.03
HADS Depression	4.62 (3.42)	3.80 (3.35)	1.01	.314	0.24
ABI Severity (PTA)					
Mild (< 24 hours)	2 (5%)	1 (2.5%)			
Moderate (< 1 week)	2 (5%)	2 (5%)			
Severe (> 1 week)	19 (49%)	12 (31%)			
Not Applicable		1 (2.5%)	0.24	.887	.080

Appendix D

Raw SPSS Output

Regression Models

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.137[b]	.019	-.177	8.374	.019	.096	3	15	.961
2	.510[c]	.260	-.110	8.132	.241	1.302	3	12	.319
3	.934[d]	.873	.673	4.413	.613	6.749	5	7	.013

a. SEX = Male

b. Predictors: (Constant), TOPF, AGE, YR_A_INJURY

c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog, SEQ_EE_P, SEQ_ER_I, IRI_EMPATHY,

SEQ_ER_P, SEQ_EE_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.214	3	6.738	.096	.961[c]
	Residual	1051.786	15	70.119		
	Total	1072.000	18			
2	Regression	278.426	6	46.404	.702	.654[d]
	Residual	793.574	12	66.131		
	Total	1072.000	18			
3	Regression	935.665	11	85.060	4.367	.031[e]
	Residual	136.335	7	19.476		
	Total	1072.000	18			

a. SEX = Male
b. Dependent Variable: SPRS_P_Sub_work
c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY
d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.372[b]	.138	-.077	6.575	.138	.641	3	12	.603
2	.514[c]	.265	-.226	7.013	.126	.516	3	9	.682
3	.792[d]	.627	-.400	7.495	.362	.776	5	4	.614

a. SEX = Female

b. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83.160	3	27.720	.641	.603[c]
	Residual	518.777	12	43.231		
	Total	601.938	15			
2	Regression	159.271	6	26.545	.540	.767[d]
	Residual	442.667	9	49.185		
	Total	601.938	15			
3	Regression	377.265	11	34.297	.611	.766[e]
	Residual	224.672	4	56.168		
	Total	601.938	15			

a. SEX = Female

b. Dependent Variable: SPRS_P_Sub_work

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

e. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.171[b]	.029	-.165	7.637	.029	.151	3	15	.927
2	.464[c]	.216	-.177	7.675	.186	.950	3	12	.447
3	.953[d]	.908	.764	3.435	.693	10.579	5	7	.004

a. SEX = Male

b. Predictors: (Constant), TOPF, AGE, YR_A_INJURY

c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog, SEQ_EE_P, SEQ_ER_I, IRI_EMPATHY, SEQ_ER_P, SEQ_EE_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.399	3	8.800	.151	.927[c]
	Residual	874.759	15	58.317		
	Total	901.158	18			
2	Regression	194.320	6	32.387	.550	.762[d]
	Residual	706.838	12	58.903		
	Total	901.158	18			
3	Regression	818.547	11	74.413	6.305	.011[e]
	Residual	82.610	7	11.801		
	Total	901.158	18			

a. SEX = Male

b. Dependent Variable: SPRS_P_Sub_rel

c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY

d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

e. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog, SEQ_EE_P, SEQ_ER_I, IRI_EMPATHY, SEQ_ER_P, SEQ_EE_I

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.292[b]	.085	-.143	3.979	.085	.373	3	12	.774
2	.338[c]	.114	-.477	4.522	.029	.097	3	9	.960
3	.761[d]	.579	-.580	4.678	.465	.882	5	4	.564

a. SEX = Female

b. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.731	3	5.910	.373	.774[c]
	Residual	190.019	12	15.835		
	Total	207.750	15			
2	Regression	23.700	6	3.950	.193	.971[d]
	Residual	184.050	9	20.450		
	Total	207.750	15			
3	Regression	120.222	11	10.929	.499	.836[e]
	Residual	87.528	4	21.882		
	Total	207.750	15			

a. SEX = Female

b. Dependent Variable: SPRS_P_Sub_rel

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

e. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.131[b]	.017	-.180	6.742	.017	.087	3	15	.966
2	.451[c]	.203	-.195	6.786	.186	.936	3	12	.454
3	.929[d]	.864	.649	3.677	.660	6.774	5	7	.013

a. SEX = Male

b. Predictors: (Constant), TOPF, AGE, YR_A_INJURY

c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog, SEQ_EE_P, SEQ_ER_I, IRI_EMPATHY, SEQ_ER_P, SEQ_EE_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.846	3	3.949	.087	.966[c]
	Residual	681.838	15	45.456		
	Total	693.684	18			
2	Regression	141.117	6	23.520	.511	.789[d]
	Residual	552.567	12	46.047		
	Total	693.684	18			
3	Regression	599.041	11	54.458	4.028	.038[e]
	Residual	94.643	7	13.520		
	Total	693.684	18			

a. SEX = Male

b. Dependent Variable: SPRS_P_Sub_living

c. Predictors: (Constant), TOPF, AGE, YR_A_INJURY

d. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog

e. Predictors: (Constant), TOPF, AGE, YR_A_INJURY, SIET_TOTAL, SIMT_Total, EET_Emot_Recog, SEQ_EE_P, SEQ_ER_I, IRI_EMPATHY, SEQ_ER_P, SEQ_EE_I

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.285[b]	.081	-.148	4.473	.081	.355	3	12	.787
2	.623[c]	.389	-.019	4.214	.307	1.508	3	9	.278
3	.848[d]	.720	-.052	4.281	.331	.944	5	4	.537

a. SEX = Female

b. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

ANOVA[a,b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.294	3	7.098	.355	.787[c]
	Residual	240.144	12	20.012		
	Total	261.438	15			
2	Regression	101.609	6	16.935	.954	.504[d]
	Residual	159.828	9	17.759		
	Total	261.438	15			
3	Regression	188.128	11	17.103	.933	.584[e]
	Residual	73.309	4	18.327		
	Total	261.438	15			

a. SEX = Female

b. Dependent Variable: SPRS_P_Sub_living

c. Predictors: (Constant), TOPF, YR_A_INJURY, AGE

d. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL

e. Predictors: (Constant), TOPF, YR_A_INJURY, AGE, EET_Emot_Recog, SIMT_Total, SIET_TOTAL, SEQ_ER_P, IRI_EMPATHY, SEQ_EE_P, SEQ_EE_I, SEQ_ER_I

ANOVAs Comparing SEX x Condition on SEQ: ER and EE Subscales (Participant)

Descriptive Statistics

Dependent Variable: SEQ_ER_P

CONDITION	SEX	Mean	Std. Deviation	N
ABI	Male	21.68	4.529	22
	Female	21.31	2.651	16
	Total	21.53	3.811	38
Control	Male	20.47	4.777	19
	Female	22.73	3.305	15
	Total	21.47	4.287	34
Total	Male	21.12	4.627	41
	Female	22.00	3.022	31
	Total	21.50	4.014	72

Tests of Between-Subjects Effects

Dependent Variable: SEQ_ER_P

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	44.120[a]	3	14.707	.909	.441	.039	2.728	.239
Intercept	32697.817	1	32697.817	2021.539	.000	.967	2021.539	1.000
CONDITION	.199	1	.199	.012	.912	.000	.012	.051
SEX	15.724	1	15.724	.972	.328	.014	.972	.163
CONDITION * SEX	30.413	1	30.413	1.880	.175	.027	1.880	.272
Error	1099.880	68	16.175					
Total	34426.000	72						
Corrected Total	1144.000	71						

a. R Squared = .039 (Adjusted R Squared = -.004)

b. Computed using alpha = .05

Descriptive Statistics

Dependent Variable: SEQ_EE_P

CONDITION	SEX	Mean	Std. Deviation	N
ABI	Male	16.36	2.985	22
	Female	16.63	2.363	16
	Total	16.47	2.709	38
Control	Male	16.53	2.674	19
	Female	16.60	3.019	15
	Total	16.56	2.787	34
Total	Male	16.44	2.811	41
	Female	16.61	2.654	31
	Total	16.51	2.727	72

Tests of Between-Subjects Effects

Dependent Variable: SEQ_EE_P

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	.808[a]	3	.269	.035	.991	.002	.104	.056
Intercept	19234.910	1	19234.910	2481.087	.000	.973	2481.087	1.000
CONDITION	.083	1	.083	.011	.918	.000	.011	.051
SEX	.494	1	.494	.064	.801	.001	.064	.057
CONDITION * SEX	.155	1	.155	.020	.888	.000	.020	.052
Error	527.178	68	7.753					
Total	20163.000	72						
Corrected Total	527.986	71						

a. R Squared = .002 (Adjusted R Squared = -.043)

b. Computed using alpha = .05

ANOVAs Comparing SEX x Condition on SEQ: ER and EE Subscales (Informant)

Descriptive Statistics

Dependent Variable: SEQ_ER_I

CONDITION	SEX	Mean	Std. Deviation	N
ABI	Male	10.82	2.423	22
	Female	11.63	3.052	16
	Total	11.16	2.697	38
Control	Male	12.63	2.338	19
	Female	14.00	1.134	15
	Total	13.24	2.001	34
Total	Male	11.66	2.526	41
	Female	12.77	2.591	31
	Total	12.14	2.596	72

Tests of Between-Subjects Effects

Dependent Variable: SEQ_ER_I

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	99.167[a]	3	33.056	5.924	.001	.207	17.772	.945
Intercept	10597.591	1	10597.591	1899.191	.000	.965	1899.191	1.000
CONDITION	77.195	1	77.195	13.834	.000	.169	13.834	.956
SEX	20.821	1	20.821	3.731	.058	.052	3.731	.478
CONDITION * SEX	1.388	1	1.388	.249	.620	.004	.249	.078
Error	379.444	68	5.580					
Total	11088.000	72						
Corrected Total	478.611	71						

a. R Squared = .207 (Adjusted R Squared = .172)

b. Computed using alpha = .05

Descriptive Statistics

Dependent Variable: SEQ_EE_I

CONDITION	SEX	Mean	Std. Deviation	N
ABI	Male	9.68	3.030	22
	Female	10.69	2.892	16
	Total	10.11	2.975	38
Control	Male	12.42	2.694	19
	Female	13.27	1.534	15
	Total	12.79	2.267	34
Total	Male	10.95	3.162	41
	Female	11.94	2.645	31
	Total	11.38	2.971	72

Tests of Between-Subjects Effects

Dependent Variable: SEQ_EE_I

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	145.100[a]	3	48.367	6.827	.000	.231	20.480	.970
Intercept	9334.322	1	9334.322	1317.490	.000	.951	1317.490	1.000
CONDITION	124.467	1	124.467	17.568	.000	.205	17.568	.985
SEX	15.081	1	15.081	2.129	.149	.030	2.129	.301
CONDITION * SEX	.113	1	.113	.016	.900	.000	.016	.052
Error	481.775	68	7.085					
Total	9943.000	72						
Corrected Total	626.875	71						

a. R Squared = .231 (Adjusted R Squared = .198)

b. Computed using alpha = .05

ANOVAs Comparing Sex X Group on TASIT-S Subscales

Descriptive Statistics

Dependent Variable: EET_Emot_Recog

SEX	CONDITION	Mean	Std. Deviation	N
Male	ABI	4.30	2.120	23
	Control	6.84	1.214	19
	Total	5.45	2.166	42
Female	ABI	6.50	1.506	16
	Control	5.27	2.492	15
	Total	5.90	2.103	31
Total	ABI	5.21	2.166	39
	Control	6.15	2.017	34
	Total	5.64	2.137	73

Tests of Between-Subjects Effects

Dependent Variable: EET_Emot_Recog

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	82.411[a]	3	27.470	7.695	.000	.251	23.084	.984
Intercept	2330.518	1	2330.518	652.808	.000	.904	652.808	1.000
SEX	1.708	1	1.708	.478	.492	.007	.478	.105
CONDITION	7.553	1	7.553	2.116	.150	.030	2.116	.300
SEX * CONDITION	63.127	1	63.127	17.683	.000	.204	17.683	.986
Error	246.329	69	3.570					
Total	2654.000	73						
Corrected Total	328.740	72						

a. R Squared = .251 (Adjusted R Squared = .218)

b. Computed using alpha =

Descriptive Statistics

Dependent Variable: SIMT_Total

SEX	CONDITION	Mean	Std. Deviation	N
Male	ABI	24.35	5.140	23
	Control	29.26	5.064	19
	Total	26.57	5.619	42
Female	ABI	27.94	4.837	16
	Control	27.73	5.910	15
	Total	27.84	5.292	31
Total	ABI	25.82	5.266	39
	Control	28.59	5.422	34
	Total	27.11	5.481	73

Tests of Between-Subjects Effects

Dependent Variable: SIMT_Total

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	280.351[a]	3	93.450	3.425	.022	.130	10.274	.747
Intercept	53012.699	1	53012.699	1942.814	.000	.966	1942.814	1.000
SEX	18.835	1	18.835	.690	.409	.010	.690	.130
CONDITION	98.524	1	98.524	3.611	.062	.050	3.611	.466
SEX * CONDITION	116.343	1	116.343	4.264	.043	.058	4.264	.530
Error	1882.772	69	27.287					
Total	55813.000	73						
Corrected Total	2163.123	72						

a. R Squared = .130 (Adjusted R Squared = .092)

b. Computed using alpha =

Descriptive Statistics

Dependent Variable: SIET_TOTAL

SEX	CONDITION	Mean	Std. Deviation	N
Male	ABI	22.95	2.781	20
	Control	29.16	2.853	19
	Total	25.97	4.196	39
Female	ABI	27.13	2.553	16
	Control	26.13	5.630	15
	Total	26.65	4.278	31
Total	ABI	24.81	3.379	36
	Control	27.82	4.496	34
	Total	26.27	4.215	70

Tests of Between-Subjects Effects

Dependent Variable: SIET_TOTAL

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	390.883[a]	3	130.294	10.299	.000	.319	30.898	.998
Intercept	47895.281	1	47895.281	3785.918	.000	.983	3785.918	1.000
SEX	5.710	1	5.710	.451	.504	.007	.451	.102
CONDITION	117.382	1	117.382	9.279	.003	.123	9.279	.851
SEX * CONDITION	223.616	1	223.616	17.676	.000	.211	17.676	.985
Error	834.960	66	12.651					
Total	49539.000	70						
Corrected Total	1225.843	69						

a. R Squared = .319 (Adjusted R Squared = .288)

b. Computed using alpha =

ANOVAs Comparing Sex X Group on IRI Empathy

Descriptive Statistics

Dependent Variable: IRI_EMPATHY

CONDITION	SEX	Mean	Std. Deviation	N
ABI	Male	43.22	11.497	23
	Female	58.63	17.130	16
	Total	49.54	15.853	39
Control	Male	45.47	8.222	19
	Female	59.73	12.925	15
	Total	51.76	12.625	34
Total	Male	44.24	10.094	42
	Female	59.16	15.000	31
	Total	50.58	14.385	73

Tests of Between-Subjects Effects

Dependent Variable: IRI_EMPATHY

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	4034.502[a]	3	1344.834	8.540	.000	.271	25.621	.992
Intercept	190297.064	1	190297.064	1208.476	.000	.946	1208.476	1.000
CONDITION	50.253	1	50.253	.319	.574	.005	.319	.086
SEX	3906.959	1	3906.959	24.811	.000	.264	24.811	.998
CONDITION * SEX	5.850	1	5.850	.037	.848	.001	.037	.054
Error	10865.333	69	157.469					
Total	201624.000	73						
Corrected Total	14899.836	72						

a. R Squared = .271 (Adjusted R Squared = .239)

b. Computed using alpha =